



FEASIBILITY STUDY OF A CO-DIGESTION AD FACILITY IN NEW YORK AND AN OVERVIEW OF CO-DIGESTION PERMITTING

**2007 AgSTAR Conference
Presented by: Brandon Moffatt - CRA
Location: Sacramento, CA
November 27th, 2007**



New York digester



Agricultural Services

A division of Conestoga-Rovers and Associates



OBJECTIVES OF FEASIBILITY STUDY

- Establish a community manure management program to strengthen local livestock industry
- Generate a renewable biogas source to displace fossil fuel and reduce GHG emissions by diverting organic waste
- Generate a renewable by-product stream based on recovered solids for sale
- **A Feasibility Study / Economic Modeling should always be completed for a proposed AD project to ensure viability**



Agricultural Services

A division of Conestoga-Rovers and Associates



DESCRIPTION OF BIOMASS FEEDSTOCK SOURCES

- Six local dairy operations supply manure from
 - 3,450 cows, ~60,000 gal/day, ~ 83,500 ton/year
 - 13% Total Solids (TS);
 - Volatile solids (VS) 85% of TS;
 - 45% VS actually digested;
 - 0.48 m³ biogas/kg VS digested
- Biomass feedstock includes manure and organic waste sources
- Concerns over sand bedding need to be resolved





DESCRIPTION OF BIOMASS FEEDSTOCK SOURCES

OTHER ORGANIC WASTE

<i>Organic Waste Type</i>	<i>Annual Waste Quantity US ton per yr</i>	<i>Generation Timeframe</i>
Green Beans	9,000	June- Oct
Sauerkraut	17,500	Aug-Nov
Sweet Corn	52,500	Aug-Oct
Beets	10,000	
Carrots	3,500	
Yard Waste	112.0	April-Oct
Municipal sludge	20,180	Daily
Fat/Oil/Grease	604.1	Daily
Food	756.2	Daily
Total	132,409	



Agricultural Services

A division of Conestoga-Rovers and Associates



ANAEROBIC DIGESTER CONCEPTUAL PROCESS DESIGN

- Feedstock Collection and Storage
 - Transport to AD Facility & On-site Storage
- Pre-and Post Treatment Options
 - Organics Grinding, Pasteurization, and Blending
- Anaerobic Digestion
 - Desired Moisture Content of 88 to 90%
 - Neutral pH in range of 6.8 to 7.2
 - Completely Mixed AD system
 - Thermophilic operating temperature (55 to 60°C)
 - Hydraulic retention time (HRT) of approximately 15 days



Agricultural Services

A division of Conestoga-Rovers and Associates



ANAEROBIC DIGESTER CONCEPTUAL PROCESS DESIGN

- Biogas Treatment and Utilization
 - Biogas may be treated with minor gas cleanup of water vapor and H_2S and compressed to 20 psi
 - Biogas may be treated by removing H_2O , H_2S , carbon dioxide (CO_2), and siloxanes for pipeline quality (may not need to remove CO_2 but 600-900 psi)
- Disposal/reuse of process residuals
 - Digestate Dewatering and Reuse
 - Digestate must be dewatered to separate the solid and liquid fractions
 - Solids approximately 70% dry matter, with 20-40% of phosphorus contained in solid portion
 - Solids represent a revenue stream for sale as animal bedding or compost





ANAEROBIC DIGESTER CALCULATION MODEL

- Model is used to determine biogas generation rate, solid and liquid streams and cost and revenue parameters
- Two scenarios:
 - Minor biogas cleaning for local use
 - Advanced biogas cleaning for pipeline grade quality
- Total biomass input represents 197,600 tons/year at 10.6 % mixed solids



Agricultural Services

A division of Conestoga-Rovers and Associates



ANAEROBIC DIGESTER CALCULATION MODEL

- Key Model Parameters include:
 - Manure properties (moisture content, density);
 - Organic waste properties (moisture content, density);
 - Transportation unit costs (fixed costs for loading/unloading, etc.);
 - Biogas generation parameters (total solids, volatile solids in total solids, etc.);
 - Capital cost factors (scale factors, equation co-efficient, operating life);
 - Operating cost factors (staff schedule, salary, maintenance); and
 - Revenue factors (sale price for methane and digestate solids, etc.)



Agricultural Services

A division of Conestoga-Rovers and Associates



ANAEROBIC DIGESTER CALCULATION MODEL

- Transportation Costs
 - Transportation unit costs are broken down into two components - distance fixed cost (DFC)/distance variable cost (DVC)
 - Liquid manure loading/unloading costs: \$3.81/ton;
 - Solid and liquid organics loading/unloading costs: \$0.40/ton;
 - Liquid manure/organics hauling costs: \$0.18/ton/mile
- Calculations by Biomass Type
 - Inputs and intermediate biogas generation calculations evaluated independently
 - Amount of methane and biogas produced summed to estimate total production





ANAEROBIC DIGESTER CALCULATION MODEL

- Plant Mass and Energy Balance
 - Combined manure and organic waste streams provide overall net input of mass and energy
 - The model identifies parameters such as:
 - Total mixed biomass quantity (197,600 wet tons per year);
 - Mixed biomass solids content (10.6%);
 - Biogas production (1,016 cfm);
 - Methane content in biogas (64%);
 - Biogas fuel heating value; and
 - Equivalent gross electrical power generation capacity (4.3 MWe)





ANAEROBIC DIGESTER CALCULATION MODEL

- Capital and Operating Cost Analysis
 - Capital Costs
 - Primary inputs are volume of biomass throughput per day and volume of biogas production per day
 - Desired pre-tax return on capital is 20% annually with a plant life of 30 years
 - Using a Capital Recovery Factor (CRF) of 20% estimates payback period of 6 to 7 years at an interest rate of 7 to 10% on borrowed capital
 - Operating Costs
 - 6% of capital costs as annual maintenance cost
 - Transporting manure and feedstock to the plant and returning the digestate to the farms

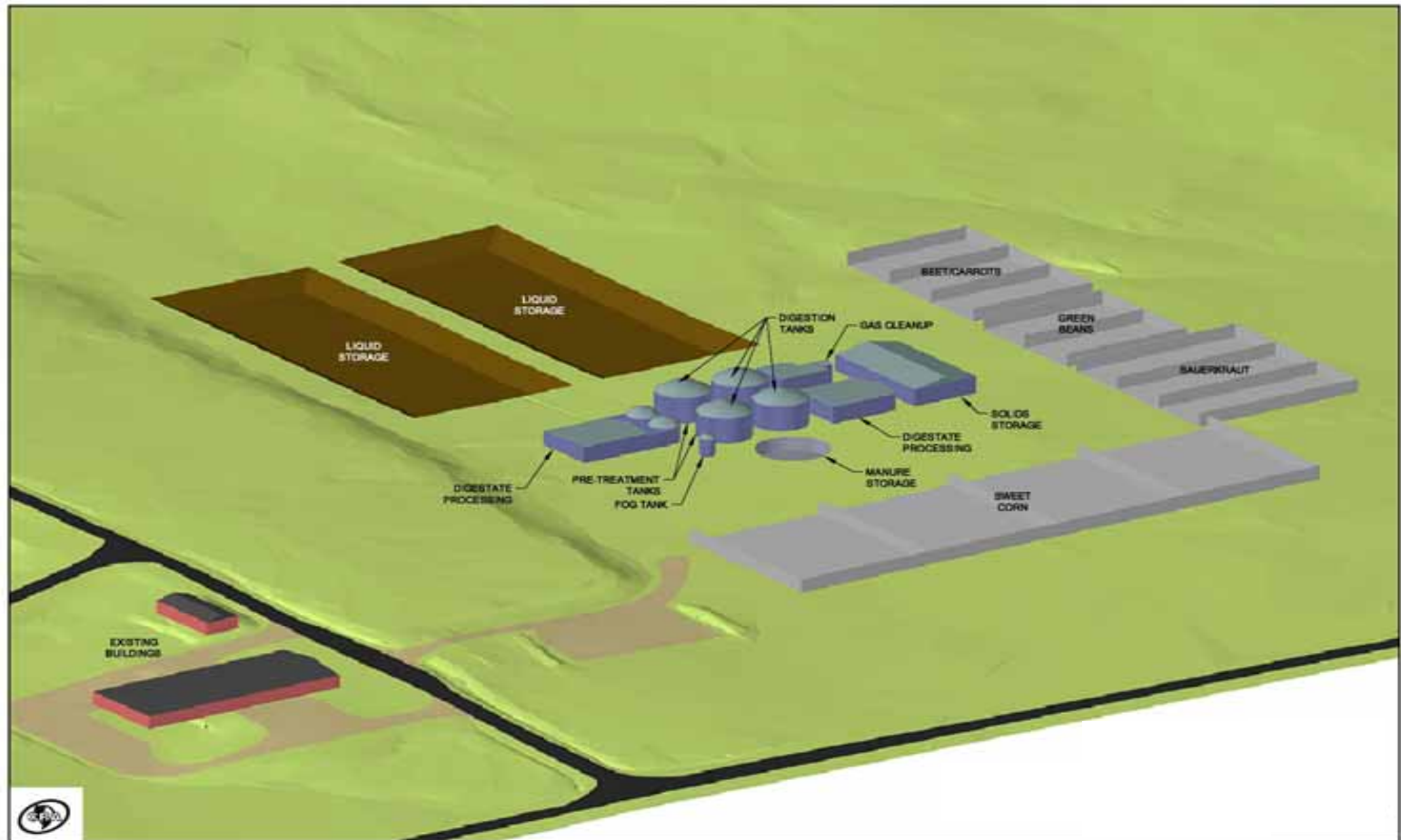


Agricultural Services

A division of Conestoga-Rovers and Associates



3-D RENDERING OF FACILITY



48387-00(001)GH-WAG01 NOV 26/2007



Agricultural Services

A division of Conestoga-Rovers and Associates



REVENUE ANALYSIS

- Revenue streams identified within the model include:
 - Gas sales: \$7/MMBTU for minor biogas cleaning and \$8/MMBTU for advanced biogas cleaning
 - Tipping fees: \$8/ton for organics
 - Carbon credits: \$4/ton
 - Bedding sales or other alternate utilization (daily cover): \$25/ton
 - Subsidies: \$0



Agricultural Services

A division of Conestoga-Rovers and Associates



ECONOMIC SENSITIVITY ANALYSIS

- Key parameters can be varied to enable sensitivity studies of any parameter including:
 - Organic tipping fee;
 - Methane sale price;
 - Transportation and operating costs; and
 - Biogas yield
- Organic tipping fee and methane sales
 - Most significant factors in determining viability of the project
- Alternate capital sources should be considered
 - NYSERDA and other state and local grants



Agricultural Services

A division of Conestoga-Rovers and Associates



STUDY CONCLUSIONS

- Scenarios identified as not profitable initially, but have since worked to refine capital costs, source more profitable feedstocks, and seek out capital grants
- Preliminary nature of data → Further Evaluation
- Important areas for determining potential economic viability:
 - Co-locating the AD plant at the landfill;
 - Sharing administrative and weigh scale infrastructure;
 - Recovery of waste heat from LFG engines; and
 - Disposal of surplus liquid digestate into landfill



Agricultural Services

A division of Conestoga-Rovers and Associates



CO-DIGESTION

- Previous Study is an Example of Co-Digestion
 - Utilization of Non-Manure Based Organics
- Use of off-farm organics greatly improves chances of project viability by:
 - Improving biogas production;
 - Allowing for additional revenue stream (tipping fees)
- Regulation of off-farm organics varies by region with permitting requirements varying from either vague or non-existent



Agricultural Services

A division of Conestoga-Rovers and Associates



CO-DIGESTION – CALIFORNIA

- CA Integrated Waste Management Board (CIWMB) has jurisdiction over solid waste disposal, recycling, and composting
- CIWMB does not have a statutory or regulatory definition for AD, which is something that would help resolve jurisdictional questions for project developers (Ambiguity)
- Most dairies are now regulated through WDR Orders which are essentially state permits issued by the regional water quality boards with the exception of Santa Ana (170 dairies – general NPDES permit)
- Currently, 22 AD systems within the state utilizing some form of co-digestion



Agricultural Services

A division of Conestoga-Rovers and Associates



CO-DIGESTION – CALIFORNIA

- Regulatory Challenges include:
 - Water, Air, Electricity, Natural Gas, and Solid Waste Management
- Other Agencies involved:
 - CARB & 35 local air pollution control districts – air emissions from mobile and stationary sources
 - Only APCD regulating AD at dairies in CA is San Joaquin Valley
 - SWRCB & 9 regional water quality boards – protect and preserve water resources
 - CPUC – regulates privately owned electric and natural gas companies



Agricultural Services

A division of Conestoga-Rovers and Associates



CO-DIGESTION – CALIFORNIA: CENTRAL VALLEY

- New Water Regulations adopted in May 2007
 - WDRs
- Approach by regulators:
 - Case by case review of individual WDRs
- What makes this an issue?
- **1,600 of 2,000 dairies are in Central Valley**



Agricultural Services

A division of Conestoga-Rovers and Associates



CO-DIGESTION – CALIFORNIA: CENTRAL VALLEY

- CVWRB concerns:
 - Use of off-site materials will increase salt and nitrate content
 - Ability to safely store additional volumes
 - Leakage from digestate storages
- Need to evaluate possibility of developing a permitting process for complex, cross-cutting projects such as AD which involves a centralized, stream-lined permit process that eases regulatory burden and allows CA to meet GHG goals





CO-DIGESTION - WISCONSIN

- As of Winter 2006, 21 systems (8.3 MW) were operating and 23 additional systems were planned (5.4 MW) with most systems being mesophilic plug-flow systems
- DNR allows industrial wastewater to be mixed with liquid manure at a volume less than 10% of the volume of the mixture at the time it is land applied, and will provide exemptions on a case-by-case basis



Agricultural Services

A division of Conestoga-Rovers and Associates



CO-DIGESTION - WISCONSIN

- As of July 1st, 2007, AD systems shall be designed and constructed in accordance with Standard 313 but may required additional design requirements depending on waste stream characterization
- For anything other than manure going in, written USDA approval is required with daily records of volumes of manure and non-manure added required with additional monitoring for other materials (i.e. metals) based on waste stream characterization



Agricultural Services

A division of Conestoga-Rovers and Associates



CO-DIGESTION - WISCONSIN

- Green Tier applicants at the Tier 2 level (only) may request that this exemption be expanded to allow the addition of industrial liquid wastes from food products processing operations to anaerobic digesters at a volume less than 30% of the total daily input volume.
- Allowed to apply the materials in accordance with NMP or WPDES permit.



Agricultural Services

A division of Conestoga-Rovers and Associates



CONCLUSIONS

- A number of states have operating permits for co-digestion, but require a hybrid of permits including CAFO/AFO, MSW, wastewater treatment, air emissions, and nutrient management
- Unlike, USEPA Part 503 regulations that set minimum standards for reuse of biosolids, currently, no comparable federal standards for operation of AD facilities for manure and food waste exist.



Agricultural Services

A division of Conestoga-Rovers and Associates



**QUESTIONS/
COMMENTS**

THANK YOU



Agricultural Services

A division of Conestoga-Rovers and Associates